

**MGT 910 Seminar in Operations Management 1-3(1-3,0)** New methodological developments, both analytical and philosophical, in operations management; development of theory of management science; converting management theory into practice while considering behavioral and economic aspects of the problem. *Preq:* Consent of instructor.

**MGT 911 Seminar in Decision Theory 1-3(1-3,0)** Framework and methodology for management decision making in a statistical setting. *Preq:* Consent of instructor.

**MGT 916 Directed Readings in Management 1-3(1-3,0)** Directed reading and research in the student's area of interest. May be repeated for a maximum of three credits. *Preq:* Consent of instructor.

**MGT 918 Seminar in Management Support Systems 3(3,0)** Contemporary topics in decision-oriented information systems research; structure of the field, research methodologies, and research opportunities. *Preq:* MGT 818 or consent of instructor.

**MGT 921 Seminar in the Science and Practice of Business and Economic Modeling 3(3,0)** Current literature used as a resource for studying and analyzing selected topics important in the design and development of simulation models. Students lead and participate in group discussions. *Preq:* MGT 913 or equivalent.

**MGT 925 Seminar on Information Systems Foundations 3(3,0)** Foundations of information systems research including classical framework literature. Research philosophies, key methodologies and relevant theoretical underpinnings are discussed and debated.

**MGT 927 Seminar in Organizational Impacts of Information Systems 3(3,0)** Current theoretical and empirical research related to the organizational impacts of information systems. Research focuses on strategic and structural impacts of information technologies within and across organizations.

**MGT 991 Doctoral Dissertation Research 1-12**

## MARKETING

**MKT 623 Promotional Strategy 3(3,0)** Emphasizes promotion as the communication function of marketing. Attention is given to communication theory and promotion's relation to mass and interpersonal communication. Factors affecting the promotional decision-making process are explored, and promotion as a competitive tool is examined. *Preq:* MKT 301 or consent of instructor.

**MKT 627 International Marketing 3(3,0)** Study of marketing from the international point of view. Emphasis is on the necessary modification of marketing thinking and practice for foreign markets due to individual environmental differences. *Preq:* MKT 301.

**MKT 628 Services Marketing 3(3,0)** Exploration and study of the nature of service organizations and the principles that guide the marketing of their products. Emphasis is on a marketing mix that is fundamentally different than that found in traditional goods marketing. *Preq:* MKT 301 or consent of instructor.

**MKT 629 Public and Nonprofit Marketing 3(3,0)** Examines the role and application of marketing in public and nonprofit settings. Focuses on a conceptual understanding of the marketing discipline and marketing processes and shows how basic concepts and principles of marketing are applicable to public and nonprofit organizations. *Preq:* MKT 301 or consent of instructor.

**MKT 630 Marketing Product Management 3(3,0)** Management of the firm's product or service offerings. Topics include new product screening, evaluation, and development; product line and mix analysis; abandonment decisions; brand manager's role; new product development department and others. Emphasis is on decision making. *Preq:* MGT 310, MKT 301; or consent of instructor.

**MKT 631 Marketing Research 3(3,0)** Research used in marketing decision making. Primary emphasis is on methods and techniques used in planning, collecting, processing and utilizing information. Topics include research design, sources of information, questionnaire design, sampling, data collection, and data analysis. *Preq:* MGT 310, MKT 301, MTHSC 301; or consent of instructor.

**MKT 695 Selected Topics 3(3,0)** In-depth examination of timely topics in marketing. May be repeated for credit, but only if different topics are covered. *Preq:* MKT 301 or consent of instructor.

**MKT (M B A) 824 Management of Sales Operations 3(3,0)** See M B A 824.

**MKT (M B A) 825 Advertising and Promotional Management 3(3,0)** See M B A 825.

**MKT (M B A) 826 Business Marketing 3(3,0)** See M B A 826.

**MKT (M B A) 828 Services Marketing 3(3,0)** See M B A 828.

**MKT (M B A) 860 Advanced Marketing Strategy 3(3,0)** See M B A 860.

**MKT 861 Marketing Research 3(3,0)** Marketing theory and critical thinking to support decision making; data analysis and advanced marketing models are employed with emphasis on building assessment skills. Primary topics are gathering primary and secondary data, questionnaire design, sampling, experimental design, data collection, and data analysis. *Preq:* Enrollment in MS in Marketing or M B A (MKT) 860 or consent of instructor.

**MKT 862 Quantitative Methods in Marketing 3(3,0)** Advanced quantitative analytic methods and their use in translating facts into meaningful information. Provides practical understanding of several advance quantitative data analytic procedures including both predictive and interdependence techniques. Application to case analysis format to broaden analysis skills. *Preq:* MKT 861 or consent of instructor.

**MKT 863 Buyer Behavior 3(3,0)** Buyer decision processes in the purchase and consumption of goods and services by both businesses and consumers. Topics include economic, sociocultural, and psychological aspects of buying behavior; decision-making processes and buyer choice; individual and group level influences on consumer behavior; and implications of consumer behavior for marketers. *Preq:* Enrollment in MS in Marketing or M B A (MKT) 860 or consent of instructor.

**MKT 865 Seminar in Marketing Management 3(3,0)** Current research and practice in components of marketing management. In-depth discussion of marketing mix variables, segmentation, targeting and positioning, and budget-related issues. *Preq:* Enrollment in MS in Marketing.

**MKT 866 Selected Topics in Marketing 3(3,0)** Current topics in marketing theory and research. Topics vary with developments in the marketing profession. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* M B A (MKT) 860 or MKT 865 or consent of instructor.

**MKT 870 Master's Research Project 1-5** Student development and participation in research. Application to a current business problem or development of new research. Formal presentation and written report are required. May be repeated for a maximum of five credits. *Preq:* Enrollment in MS in Marketing and consent of graduate advisor.

## MASTER OF BUSINESS ADMINISTRATION (MBA)

See courses listed under Business Administration.

## MATERIALS SCIENCE AND ENGINEERING

**MS&E 800 Seminar in Materials Research 1(1,0)** Special topics and original research in materials engineering. Credit may be earned for more than one semester.

**MS&E 811 Materials Science and Engineering I: Structure, Bonding, and Synthesis 4(4,0)** Fundamentals of materials science and engineering; crystal structures, chemical and atomic bonding, mechanical properties, periodicity in relation to material engineering, methods of materials synthesis. *Preq:* BS degree in Materials Science and Engineering, Physics, Chemistry, or appropriate engineering discipline or consent of instructor.

**MS&E 812 Materials Science and Engineering II: Electronic, Magnetic, Thermal, and Optical Properties of Materials 4(4,0)** Continuation of MS&E 811: electronic, magnetic, thermal, and optical properties of materials; structure/properties and application of metals, semiconductors, ceramics, and polymers and their importance in materials science and engineering. *Preq:* MS&E 811 or consent of instructor.

**MS&E 820 Deformation Mechanisms in Solids 3(3,0)** Dislocation theory of solids; mechanisms of plastic deformation in single crystals and polycrystalline aggregates of metals and nonmetals; ductile and brittle fractures; fatigue, creep, and stress corrosion cracking of metals. *Preq:* Consent of instructor.

**MS&E 825 Solid State Materials Science 3(3,0)** Bonding and structure of crystalline materials as related to mechanical, thermal, and chemical properties of solids.

**MS&E 826 Phase Equilibria in Materials Systems 3(3,0)** Advanced treatment of phase equilibria in materials systems, phase diagrams, thermodynamics of defects, surfaces, interfaces, and solutions. *Preq:* C M E 210; consent of instructor. *Coreq:* M E 810.

**MS&E 827 Kinetics of Phase Transformation 3(3,0)** Advanced treatment of the kinetics of phase transformation in materials systems including nucleation, growth, and spinodal decomposition. *Preq:* MS&E 826 or equivalent, consent of instructor.

**MS&E 828 Phase Transformations in Materials Science 3(3,0)** Advanced treatment of gas-solid, gas-liquid, liquid-solid, and solid-solid transformations in materials systems. *Preq:* MS&E 827.

**MS&E 891 Master's Thesis Research 1-12**

**MS&E 991 Doctoral Dissertation Research 1-12**

## MATHEMATICAL SCIENCES

**MTHSC 600 Theory of Probability 3(3,0)**

Principal topics include combinatorial theory, probability axioms, random variables, expected values, special discrete and continuous distributions, jointly distributed random variables, correlation, conditional expectation, law of large numbers, central limit theorem. *Preq:* MTHSC 206 or consent of instructor.

**MTHSC 603 Introduction to Statistical Theory 3(3,0)**

Principal topics include sampling distributions, point and interval estimation, maximum likelihood estimators, method of moments, least squares estimators, tests of hypotheses, likelihood ratio methods, regression and correlation analysis, introduction to analysis of variance. *Preq:* MTHSC 400 or equivalent.

**MTHSC 605 Statistical Theory and Methods II 3(3,0)**

Principal topics include simple linear regression, multiple regression and correlation analysis, one-way analysis of variance, multiple comparison, multifactor analysis of variance, experimental design. Computation and interpretation of results are facilitated through use of statistical computer packages. *Preq:* MTHSC 301.

**MTHSC 606 Sampling Theory and Methods 3(3,0)**

Probability-based treatment of sampling methodology. Theory and application of estimation techniques are treated using simple and stratified random sampling, cluster sampling, and systematic sampling. *Preq:* MTHSC 302 and 400, or consent of instructor.

**MTHSC 607 Regression and Time Series Analysis 3(3,0)**

Theory and application of the regression and time series. Approaches to empirical model building and data analysis are treated. Computation and interpretation of results are facilitated through the use of interactive statistical packages. *Preq:* MTHSC 302, 311, 400; or consent of instructor.

**MTHSC 608 Topics in Geometry 3(3,0)**

Introduction to topics in special geometries which include non-Euclidean space concepts such as projective geometry, finite geometries, and intuitive elementary topology. Brief introduction to vector geometry. *Preq:* MTHSC 206.

**MTHSC 612 Introduction to Modern Algebra 3(3,0)**

Introduction to the concepts of algebra. Topics include the number system and the elementary theory of groups, rings, and fields. *Preq:* MTHSC 311.

**MTHSC 619 Discrete Mathematical Structures I 3(3,0)**

Applies theoretical concepts of sets, functions, binary relations, graphs, Boolean algebras, propositional logic, semigroups, groups, homomorphisms, and permutation groups to computer characteristics and design, words over a finite alphabet and concatenation, binary group codes, and other communication or computer problems. *Preq:* MTHSC 311.

**MTHSC 634 Advanced Engineering Mathematics 3(3,0)**

Fourier series, Laplace and Fourier transform, and numerical methods for solving initial value and boundary-value problems in partial differential equations are developed. Applications to diffusion wave and Dirichlet problems are given. Matrix methods and special functions are utilized. *Preq:* MTHSC 208.

**MTHSC 635 Complex Variables 3(3,0)**

Elementary functions; differentiation and integration of analytic functions; Taylor and Laurent series; contour integration and residue theory; conformal mapping; Schwarz-Christoffel transformation. *Preq:* MTHSC 206.

**MTHSC 640 Linear Programming 3(3,0)**

Introduction to linear programming covering the simplex algorithm, duality, sensitivity analysis, network models, formulation of models, and the use of simplex codes to solve, interpret, and analyze problems. *Preq:* MTHSC 206, 311, or consent of instructor.

**MTHSC 641 Introduction to Stochastic Models 3(3,0)**

Introductory treatment of stochastic processes, finite-state Markov chains, queueing, dynamic programming, Markov decision processes, reliability, decision analysis, and simulation. Both theory and applications are stressed. *Preq:* MTHSC 400.

**MTHSC 653 Advanced Calculus I 3(3,0)**

Limits, continuity, and differentiation of functions of one and several variables, the Riemann integral, and vector analysis. *Preq:* MTHSC 206.

**MTHSC 654 Advanced Calculus II 3(3,0)**

Continuation of MTHSC 653. Transformations, multiple integrals, line and surface integrals, infinite sequences and series, and improper integrals. *Preq:* MTHSC 453.

**MTHSC 660 Introduction to Numerical Analysis I 3(3,0)**

Introduction to the problems of numerical analysis emphasizing computational procedures and application. Topics include sources of error and conditioning, matrix methods, systems of linear equations, nonlinear equations, interpolation and approximation by splines, polynomials and trigonometric functions. *Preq:* MTHSC 206 or 207 and 360 or equivalent.

**MTHSC 663 Mathematical Analysis I 3(3,0)**

Basic properties of the real number system, sequences and limits; continuous functions, uniform continuity and convergence; integration, differentiation, functions of several real variables, implicit function theory. *Preq:* MTHSC 206.

**MTHSC 706 Probability and Statistics for Middle Grades Teachers 3(3,0)**

Topics include organizing, classifying, and summarizing data; univariate and bivariate graphical techniques; measures of center and dispersion; correlation and simple regression; elementary probability theory, counting, and simulations; binomial and normal distributions. A graphing calculator is used. *Preq:* Graduate standing in Middle Grades Education.

**MTHSC 709 Geometry for the Middle Grades 3(3,0)**

Hands-on approach to constructions with straight-edge and compass; polygons including tessellations and polyhedra; symmetry and transformational geometry; coordinate geometry measurement with dimensional analysis; perspective drawing and related topics; history of geometry; reasoning and informal proof with congruence; and computer software, calculator use, and Internet.

**MTHSC 713 Algebra for Middle Grades Teachers 3(3,0)**

Study of elementary algebra, solution of equations, and inequalities; properties and applications of linear, quadratic, polynomial, and exponential functions and models; graphical analysis and curve-fitting of real-world data; systems of equations and basic matrix operations. A graphing calculator is used. *Preq:* Graduate standing in Middle Grades Education.

**MTHSC 714 Foundations of Mathematics for Middle Grades Teachers 3(3,0)**

Topics include logic, set theory, numeration systems; arithmetic operations and their properties on the integer, rational, and real number systems; decimals, ratio, proportion, percent, exponents, and roots. Includes an introduction to algebra and counting, permutations, and combinations. *Preq:* Graduate standing in Middle Grades Education.

**MTHSC 715 Quantitative Literacy I 3(3,0)**

Data analysis and gathering data from surveys including box-and-whisker plots, bar charts, circle graphs, and stem-and-leaf plots. Construction of surveys to gather data to test a hypothesis. All material are presented by student activities using cooperative learning and manipulatives.

**MTHSC 716 Quantitative Literacy II 3(3,0)**

Probability and simulation; application of these concepts to simulate various processes such as traffic control. All material are presented by student activities using cooperative learning and manipulatives.

**MTHSC 738 Modern Geometry for Secondary Teachers 3(3,0)**

Concepts of Euclidean geometry reviewed and extended by means of coordinates, vectors, matrices; conic sections. *Preq:* Enrollment in Secondary Education graduate program.

**MTHSC 740 Linear Programming for Secondary Teachers 3(3,0)**

Development of mathematical theory of simplex algorithm; survey of mathematical background; matrix algebra, systems of linear equations and vector spaces; problem formulation is emphasized. *Preq:* Enrollment in Secondary Education graduate program.

**MTHSC 749 Discrete Mathematics for Secondary Teachers 3(3,0)**

Discrete mathematics emphasizing applications to computer science; propositions and logic; Boolean Algebra and switching circuits; recursion and induction; relations and partially ordered sets, graphs, and trees.

- MTHSC 750 Modern Algebra for Secondary Teachers 3(3,0)** Introduction to the fundamental concepts and historical development of abstract algebra. Topics include integers, binary operations, functions, equivalence, relations, permutations, groups, polynomials, commutative rings, integral domains, and fields. *Preq:* MTHSC 311 or 753, Graduate standing in Secondary Education.
- MTHSC 753 Matrix Algebra for Secondary Teachers 3(3,0)** Matrices and systems of equations; determinants; vector spaces and linear transformations; eigenvalues. *Preq:* Graduate standing in Secondary Education.
- MTHSC 755 Combinatorial Analysis for Secondary Teachers 3(3,0)** Permutations; combinations; generating functions; recurrence relations; principle of inclusion-exclusion; partitions; Latin squares; block designs; finite geometries; graphs; codes; Polya's theorem; recreational mathematics. *Preq:* Graduate standing in Secondary Education.
- MTHSC 756 Applied Modern and Linear Algebra for Secondary Teachers 3(3,0)** Various applied problems whose solutions rely on techniques and results of linear and modern algebra. Problems are selected from such areas as economics, forest management, genetics, population growth, transportation networks, cryptography, satellite communications, electronic switching circuits, chemistry, physics, sociology, and others. *Preq:* MTHSC 721 or equivalent or consent of instructor.
- MTHSC 758 Number Theory for Secondary Teachers 3(3,0)** Topics include properties of integers, divisors, and prime numbers; fundamental properties of congruence; polynomials and primitive roots; quadratic residues. *Preq:* Graduate standing in Secondary Education.
- MTHSC 775 AP Statistics Institute 3(3,0)** Topics include probability, conditional probability, descriptive statistics, random variables, probability functions, binomial distribution, normal distribution, sampling, estimation, decision making. *Preq:* Graduate standing in Secondary Education.
- MTHSC 777 AP Calculus Institute 3(3,0)** Elementary functions, differential calculus and integral calculus; enrichment material and a theoretical perspective of calculus. Restricted to teachers who hold a current teaching certificate in secondary mathematics. Completion of this course satisfies the special certification requirements for AB-calculus teachers in South Carolina.
- MTHSC 780 Probability Theory for Secondary Teachers 3(3,0)** Calculus-based introduction to basic ideas in probability theory. Topics include basic counting techniques, fundamental axioms of probability, conditional probability, discrete and continuous distributions, and sampling distributions. Emphasizes real-world applications and the use of simulations to illustrate concepts. *Preq:* MTHSC 108, Graduate standing in Secondary Education.
- MTHSC 785 Data Analysis for Secondary Teachers 3(3,0)** Topics include data types, basic sampling and experimental designs, one- and two-sample confidence intervals and hypothesis tests, analysis of variance, model building with simple and multiple linear regression, and contingency tables. Includes a brief review of probability. Student groups propose and implement a real-world research project. *Preq:* MTHSC 301, 400, 600, or 780; Graduate standing in Secondary Education.
- MTHSC 791 Selected Topics in Mathematics Education 1-3(1-3,0)** Mathematical problems in elementary or secondary school curricula. May be repeated for credit, but only if different topics are covered. *Preq:* Graduate standing in Elementary or Secondary Education.
- MTHSC 800 Probability 3(3,0)** Study of basic probability theory with emphasis on results and techniques useful in operations research and statistics. Topics include axiomatic probability, advanced combinatorial probability, conditional informative expectation, functions of random variables, moment generating functions, distribution theory, and limit theorems. Offered fall semester only. *Preq:* MTHSC 206.
- MTHSC 801 General Linear Hypothesis I 3(3,0)** Topics include least-square estimates; Gauss-Markov theorem; confidence ellipsoids, and confidence intervals for estimable functions; tests of hypotheses; one-, two-, and higher-way layouts; analysis of variance for other models. Offered fall semester only. *Preq:* MTHSC 311, 403.
- MTHSC 802 General Linear Hypothesis II 3(3,0)** Continuation of MTHSC 801. Offered spring semester only.
- MTHSC 803 Stochastic Processes 3(3,0)** Theory and analysis of time series, recurrent events, Markov chains, random walks, renewal theory, application to communication theory and operations research. *Preq:* MTHSC 400 or 800.
- MTHSC 804 Statistical Inference 3(3,0)** Sampling distributions; maximum likelihood estimation and likelihood ratio tests; asymptotic confidence intervals for Binomial, Poisson, and Exponential parameters; two-sample methods; nonparametric tests; ANOVA; regression; model building. Offered fall semester only. *Preq:* MTHSC 400 or equivalent or consent of instructor.
- MTHSC 805 Data Analysis 3(3,0)** Methodology in analysis of statistical data emphasizing applications to real problems using computer-oriented techniques: computer plots, transformations, criteria for selecting variables, error analysis, multiple and stepwise regression, analysis of residuals, model building in time series and ANOVA problems, jackknife and random subsampling, multidimensional scaling, clustering. *Preq:* MTHSC 301, 400.
- MTHSC 806 Nonparametric Statistics 3(3,0)** Order statistics; tolerance limits; rank-order statistics; Kolmogorov-Smirnov one-sample statistics; Chi-square goodness-of-fit test; two-sample problem; linear rank statistics; asymptotic relative efficiency. Offered spring semester only. *Preq:* MTHSC 600 or 800.
- MTHSC 807 Applied Multivariate Analysis 3(3,0)** Applied multivariate analysis: computer plots of multivariate observations; multidimensional scaling; multivariate tests of means, covariances, and equality of distributions; univariate and multivariate regressions and their comparisons; MANOVA; principal components analysis; factor analysis; analytic rotations; canonical correlations. Offered fall semester only. *Preq:* MTHSC 403 and 805 or consent of instructor.
- MTHSC 808 Reliability and Life Testing 3(3,0)** Probability models and statistical methods relevant to parametric and nonparametric analysis of reliability and life testing data. Offered spring semester only. *Preq:* MTHSC 400 or equivalent.
- MTHSC 809 Time Series Analysis, Forecasting, and Control 3(3,0)** Modeling and forecasting random processes; autocorrelation functions and spectral densities; model identification, estimation and diagnostic checking; transfer function models; feedforward and feedback control schemes. Offered spring semester only. *Preq:* MTHSC 605; 600 or 800; or equivalent.
- MTHSC 810 Mathematical Programming 3(3,0)** Formulation and solution of linear programming models; mathematical development of the simplex method; revised simplex method; duality; sensitivity analysis; parametric programming, implementation and software packages. *Preq:* MTHSC 311.
- MTHSC 811 Nonlinear Programming 3(3,0)** Theoretical development of nonlinear optimization with applications, classical optimization, convex and concave functions, separable programming, quadratic programming, and gradient methods. Offered spring semester only. *Preq:* MTHSC 440, 454.
- MTHSC 812 Discrete Optimization 3(3,0)** Principal methods used in integer programming and discrete optimization; branch and bound, implicit enumeration, cutting planes, group knapsack, Lagrangian relaxation, surrogate constraints, heuristics (performance analysis), separation/branching strategies, and polynomial time algorithms for specific problems on special structures. Offered fall semester only. *Preq:* MTHSC 810 or equivalent.
- MTHSC 813 Advanced Linear Programming 3(3,0)** Development of linear programming theory using inequality systems, convex cones, polyhedra and duality; solution algorithms, and computational considerations for large scale and special structured problems using techniques of upper bounded variables, decomposition, partitioning and column generation; game theory; nonlinear representations and other methods such as ellipsoid and Karmarkar. Offered spring semester only. *Preq:* MTHSC 440, 810 or equivalent.
- MTHSC 814 Network Flow Programming 3(3,0)** Max-flow/min-cut theorem, combinatorial applications, minimum cost flow problems (transportation, shortest path, transshipment), solution algorithms (including the out-of-kilter), and implementation and computational considerations. Offered fall semester only. *Preq:* MTHSC 440, 810 or equivalent.

- MTHSC 816 Network Algorithms and Data Structures 3(3,0)** Design, analysis, and implementation of algorithms and data structures associated with the solution of problems formulated as networks and graphs; applications to graph theory, combinatorial optimization, and network programming. Offered spring semester only. *Coreq:* MTHSC 640, 810, 854, 863 or consent of instructor.
- MTHSC 817 Stochastic Models in Operations Research I 3(3,0)** Stochastic control; structure of sequential decision processes; stochastic inventory models; recursive computation of optimal policies; discrete parameter finite Markov decision processes; various optimality criteria; computation by policy improvement and other methods; existence of optimal stationary policies; stopping-rule problems; examples from financial management, maintenance and reliability, search, queuing, and shortest path. Offered spring semester only. *Preq:* MTHSC 803.
- MTHSC 818 Stochastic Models in Operations Research II 3(3,0)** Introduction to queuing theory: Markovian queues, repairman problems, queues with an embedded Markov structure, the queue GI/G/1, queues with a large number of servers, decision making in queues; introduction to reliability theory; failure distributions; stochastic models for complex systems; maintenance and replacement policies; reliability properties of multicomponent structures. Offered fall semester only. *Preq:* MTHSC 817.
- MTHSC 819 Multicriteria Optimization 3(3,0)** Theory and methodology of optimization problems with vector-valued objective functions; preference orders and domination structures; generating efficient solutions; solving multicriteria decision-making problems; noninteractive and interactive methods with applications. Offered fall semester only. *Preq:* MTHSC 810 or equivalent.
- MTHSC 820 Complementarity Models 3(3,0)** Theory, algorithms, and applications of linear and nonlinear complementarity; classes of matrices and functions and corresponding algorithms; applications to economics, mechanics, and networks; generalizations to fixed-point problems and nonlinear systems of equations. Offered spring semester only. *Preq:* MTHSC 810.
- MTHSC 821 Linear Analysis 3(3,0)** Normed spaces; Hilbert spaces, Banach spaces, linear functionals, linear operators, orthogonal systems. Offered spring semester and summer session only. *Preq:* MTHSC 454 or 453 and 853.
- MTHSC 822 Measure and Integration 3(3,0)** Rings and algebras of sets, inner and outer measures; measurability and additivity, examples on the line and in space, Lebesgue integration, types of convergence, Lebesgue spaces; integration and differentiation, product measure, Fubini theorem. Offered fall semester only. *Preq:* MTHSC 454.
- MTHSC 823 Complex Analysis 3(3,0)** Topological concepts; complex integration; local and global properties of analytic functions; power series; representation theorems; calculus of residues. Designed for nonengineering majors.
- MTHSC 825 Introduction to Dynamical Systems Theory 3(3,0)** Techniques of analysis of dynamical systems; sensitivity analysis, linear systems, stability, and control; theory of differential and difference equations. Offered fall semester only. *Preq:* MTHSC 454 and 311 or 453 and 853.
- MTHSC 826 Partial Differential Equations 3(3,0)** First-order equations: elliptic, hyperbolic, and parabolic. Second-order equations: existence and uniqueness results, maximum principles, finite difference, and Hilbert Space methods. Offered fall semester only. *Preq:* MTHSC 821 or consent of instructor.
- MTHSC 827 Dynamical System Neural Networks 3(3,0)** Modeling problems in the context of dynamical systems theory; useful methods from Lyapunov stability, local linearization, qualitative analysis using graph theory and numerical approximations; several dynamical systems neural networks including binary code recognizers and binary matrix choosers. *Preq:* MTHSC 206, 311.
- MTHSC 831 Fourier Series 3(3,0)** Fourier series with applications to solution of boundary value problems in partial differential equations of physics and engineering. Introduction to Bessel functions and Legendre polynomials.
- MTHSC 837 Calculus of Variations and Optimal Control 3(3,0)** Fundamental theory of the calculus of variations; variable end points; the parametric problem; the isoperimetric problem; constraint inequalities; introduction to the theory of optimal control; connections with the calculus of variations; geometric concepts. *Preq:* MTHSC 453 or 463.
- MTHSC 841 Applied Mathematics I 3(3,0)** Derivation of equations from conservation laws, dimensional analysis, scaling and simplification; methods such as steepest descent, stationary phase, perturbation series, boundary layer theory, WKB theory, multiple-scale analysis, and ray theory applied to problems in diffusion processes, wave propagation, fluid dynamics, and mechanics. Offered fall semester only. *Preq:* MTHSC 208 and 453 or 463.
- MTHSC 842 Applied Mathematics II 3(3,0)** Continuation of MTHSC 841.
- MTHSC 850 Computational Algebraic Geometry 3(3,0)** Covers algebraic geometry and commutative algebra via Grobner bases. Includes ideals and varieties (affine and projective), Grobner bases, elimination theory, dimensions, solving polynomial systems via eigenvalues and eigenvectors. Selected applications may include coding theory, computer vision, geometric theorem proving, integer programming, or statistics. *Preq:* MTHSC 311, 412.
- MTHSC 851 Abstract Algebra I 3(3,0)** Basic algebraic structures: groups, rings, and fields; permutation groups, Sylow theorems, finite abelian groups, polynomial domains, factorization theory, and elementary field theory. Offered spring semester only.
- MTHSC 852 Abstract Algebra II 3(3,0)** Continuation of MTHSC 851 including selected topics from ring theory and field theory. Offered fall semester only.
- MTHSC 853 Matrix Analysis 3(3,0)** Topics in matrix analysis that support an applied curriculum: similarity and eigenvalues; Hermitian and normal matrices; canonical forms; norms; eigenvalue localizations; singular value decompositions; definite matrices. *Preq:* MTHSC 311, 453 or 463.
- MTHSC 854 Theory of Graphs 3(3,0)** Connectedness; path problems; trees; matching theorems; directed graphs; fundamental numbers of the theory of graphs; groups and graphs. Offered spring semester only. *Preq:* Consent of instructor.
- MTHSC 855 Combinatorial Analysis 3(3,0)** Combinations; permutations; permutations with restricted position; Polya's theorem; principle of inclusion and exclusion; partitions; recurrence relations; generating functions; Mobius inversion; enumeration techniques; Ramsey numbers; finite projective and affine geometries; Latin rectangles; orthogonal arrays; block designs; error detecting and error correcting codes. Offered fall semester only. *Preq:* MTHSC 311.
- MTHSC 856 Theory of Error-Correcting Codes 3(3,0)** Topics include code constructions such as Hamming, cyclic, BCH, Reed-Solomon, Goppa, algebraic geometry, finite geometry, low-density parity check, convolutional and polynomial codes; code parameters and bounds; and decoding algorithms. *Preq:* MTHSC 853 or consent of instructor.
- MTHSC 857 Cryptography 3(3,0)** Classical and modern cryptography and their uses in modern communication systems are covered. Topics include entropy, Shannon's perfect secrecy theorem, Advanced Encryption Standard (AES), integer factorization, RSA cryptosystem discrete logarithm problem, Diffie-Hellman key exchange, digital signatures, elliptic curve cryptosystems, hash functions, and identification schemes. *Preq:* MTHSC 311, 400 or 600, 412 or 851.
- MTHSC 860 Introduction to Scientific Computing 3(3,0)** Floating point models, conditioning and numerical stability, numerical linear algebra, integration, systems of ordinary differential equations and zero finding; emphasis is on the use of existing scientific software. *Preq:* CP SC 110, MTHSC 208, 311.
- MTHSC 861 Advanced Numerical Analysis I 3(3,0)** Interpolation and approximation; numerical quadrature; numerical solution of functional differential equations; integral equations and overdetermined linear systems; eigenvalue problems; approximation using splines. Offered fall semester only. *Preq:* MTHSC 453, 460.
- MTHSC 863 Digital Models I 3(3,0)** Experimental mathematics; pseudostochastic processes; analytical and algebraic formulations of time-independent simulation; continuous-time simulation and discrete-time simulation; digital optimization; Fibonacci search; ravine search; gradient methods; current research in digital analysis. Offered fall semester only. *Preq:* MTHSC 311, 453, digital computer experience.

- MTHSC 865 Data Structures 3(3,0)** Representation and transformation of information; formal description of processes and data structures; tree and list structures; pushdown stacks; string and formula manipulation; hashing techniques; interrelation between data structure and program structure; storage allocation methods. Offered fall semester only. *Preq:* Computational maturity, consent of instructor.
- MTHSC 881 Mathematical Statistics 3(3,0)** Fundamental concepts of sufficiency, hypothesis testing and estimation; robust estimation; resampling (jackknife, bootstrap, etc.) methods; asymptotic theory; two-stage and sequential sampling problems; ranking and selection procedures. Offered spring semester only. *Preq:* MTHSC 403 or equivalent.
- MTHSC 884 Statistics for Experimenters 3(3,0)** Statistical methods for students who are conducting experiments; introduction to descriptive statistics, estimation, and hypothesis testing as they relate to design of experiments; higher-order layouts, factorial and fractional factorial designs, and response surface models. Offered fall semester only. *Preq:* MTHSC 206 or equivalent.
- MTHSC 885 Advanced Data Analysis 3(3,0)** Continuation of MTHSC 805 covering alternatives to ordinary least squares, influence and diagnostic considerations, robustness, special statistical computation methods. Offered spring semester only. *Preq:* MTHSC 603, 800, 805.
- MTHSC 891 Master's Thesis Research 1-12**
- MTHSC 892 Master's Project Course 1(0,1)** For students in the nonthesis option of the MS degree program in Mathematical Sciences. Successful completion includes a presentation of the master's project to the student's advisory committee and acceptance of the paper by the committee.
- MTHSC 900 Seminar in Preparing for College Teaching in the Mathematical Sciences 3(3,0)** Elements involved in being a college professor with emphasis on broadening the student's mathematical experiences within a framework of improving classroom performance. *Preq:* Completion of the departmental PhD qualifying examinations.
- MTHSC 901 Probability Theory I 3(3,0)** Axiomatic theory of probability; distribution functions; expectation; Cartesian product of infinitely many probability spaces, and the Kolmogorov consistency theorem; models of convergence; weak and strong laws of large numbers. *Preq:* MTHSC 400 and 822, or MTHSC 800 and 822 or consent of instructor.
- MTHSC 902 Probability Theory II 3(3,0)** Continuation of MTHSC 901; characteristic functions, infinitely divisible distributions, central limit theorems, laws of large numbers, conditioning, and limit properties of sums of dependent random variables, conditioning, martingales. *Preq:* MTHSC 901.
- MTHSC 927 Functional Analysis 3(3,0)** Linear operators on specific spaces, spectral theory, semigroups of operators and the Hille-Yosida theorem, applications of linear spaces and operators, convexity. *Preq:* MTHSC 821.
- MTHSC 954 Advanced Graph Theory 3(3,0)** Continuation of MTHSC 854 including the four-color theorem, domination numbers, Ramsey theory, graph isomorphism, embeddings, algebraic graph theory, and tournaments. Research papers are also examined. Offered fall semester only. *Preq:* MTHSC 854 or consent of instructor.
- MTHSC 970 Directed Studies in Mathematical Sciences 1-3(1-3,0)** Directed individual studies on topics in the mathematical sciences supervised by faculty. May be repeated for a maximum of 18 credits. *Preq:* Consent of instructor.
- MTHSC 974 Selected Topics in Mathematical Sciences 3(3,0)** Advanced topics in the mathematical sciences from current areas of interest presented in lecture format. May be repeated for a maximum 24 credits, but only if different topics are covered. *Preq:* Consent of instructor.
- MTHSC 981 Selected Topics in Mathematical Statistics and Probability 1-3(1-3,0)** Advanced topics in mathematical statistics and probability of current interest. May be repeated for credit, but only if different topics are covered.
- MTHSC 982 Selected Topics in Analysis 1-3(1-3,0)** Advanced analysis topics from current problems of interest. May be repeated for credit, but only if different topics are covered.
- MTHSC 983 Selected Topics in Computational Mathematics 1-3(1-3,0)** Advanced topics in computational mathematics and numerical analysis from current problems of interest. May be repeated for credit, but only if different topics are covered.
- MTHSC 985 Selected Topics in Algebra and Combinatorics 1-3(1-3,0)** Advanced topics in algebra and combinatorics from current problems of interest. May be repeated for credit, but only if different topics are covered.
- MTHSC 986 Selected Topics in Geometry 1-3(1-3,0)** Advanced topics in geometry from current problems of interest. May be repeated for credit, but only if different topics are covered.
- MTHSC 988 Selected Topics in Operations Research 1-3(1-3,0)** Advanced topics in operations research from current problems of interest. May be repeated for credit, but only if different topics are covered.
- MTHSC 989 Selected Topics in Mathematical Education 3(3,0)** Advanced topics in the mathematical sciences from the area of mathematics education. May be repeated for credit, but only if different topics are covered. *Preq:* Consent of instructor.
- MTHSC 991 Doctoral Dissertation Research 1-12**
- ## MECHANICAL ENGINEERING
- M E 607 Applied Heat Transfer 3(3,0)** Application-oriented extension of M E 304 considering topics in transient conduction, flow of fluids, energy exchange by radiation, and mass transfer. Applications in heat-exchanger design with emphasis on economics and variation of operating conditions from the design point. *Preq:* M E 304, consent of instructor.
- M E 616 Control of Mechanical Systems 3(3,0)** Physical modeling and feedback principles are presented for control of mechanical systems. Transient response, root locus, and frequency response principles are applied to the control of basic mechanical systems such as electric motors, fluid tanks, or thermal processes. PID control laws are emphasized. *Preq:* M E 305.
- M E 617 Mechatronics System Design 3(2,3)** Mechatronics integrates control, sensors, actuators, and computers to create a variety of electromechanical products. Includes concepts of design, appropriate dynamic system modeling, analysis, sensors, actuating devices, and real-time microprocessor interfacing and control. Laboratory experiments, simulation, and design projects are used to exemplify course concepts. *Preq:* M E 305 or consent of instructor.
- M E 620 Energy Sources and Their Utilization 3(3,0)** Covers availability and use of energy sources such as fossil fuels, solar (direct and indirect), and nuclear. Addresses energy density and constraints to use (technical and economic) for each source. *Preq:* M E 303, 304.
- M E 621 Introduction to Compressible Flow 3(3,0)** Introductory concepts to compressible flow; methods of treating one-dimensional gas dynamics including flow in nozzles and diffusers, normal shocks, moving and oblique shocks, Prandtl-Meyer Flow, Fanno Flow, Rayleigh Flow, and reaction propulsion systems. *Preq:* M E 303, 308.
- M E 622 Design of Gas Turbines 3(3,0)** Guiding principles in gas turbine cycles are reviewed. Turbine and compressor design procedures and performance prediction for both axial and radial flow machines are presented. Methods of design of rotary heat-exchangers and retrofitting gas turbine for regenerative operation are presented. Design projects are used to illustrate the procedures. *Preq:* M E 308.
- M E 623 Introduction to Aerodynamics 3(3,0)** Basic theories of aerodynamics for accurately predicting the aerodynamic forces and moments which act on a vehicle in flight. *Preq:* M E 308.
- M E 629 Thermal Environmental Control 3(3,0)** Mechanical vapor compression refrigeration cycles, refrigerants, thermoelectrical cooling systems, cryogenics, thermodynamic properties of air, psychometric charts, heating and cooling coils, solar radiation, heating and cooling loads, insulation systems. *Preq:* M E 303, 308.
- M E 630 Mechanics of Composite Materials 3(3,0)** Fundamental relationships for predicting the mechanical and thermal response of multilayered materials and structures are developed. Micromechanical and macromechanical relationships are developed for laminated materials with emphasis on continuous filament composites. The unique nature of composites and the advantages of designing with composites are discussed. *Preq:* M E 302.
- M E 632 Advanced Strength of Materials 3(3,0)** Topics in strength of materials not covered in M E 302. Three-dimensional stress and strain transformations, theories of failure, shear center, unsymmetrical bending, curved beams, and energy methods. Other topics such as stress concentrations and fatigue concepts are treated as time permits. *Preq:* M E 302.

- M E 650 Mechanical Vibrations 3(3,0)** Mathematical analysis of physical problems in the vibration of mechanical systems. Topics include linear-free vibrations, forced vibrations, and damping in single degree of freedom systems, transient vibrations, critical speeds and whirling of rotating shafts, dynamic balancing, and multidegree of freedom systems with lumped parameters. *Preq:* E M 202, M E 302, MTHSC 208.
- M E 653 Dynamic Performance of Vehicles 3(3,0)** Introduces techniques for analyzing the dynamic behavior of vehicles such as aircraft, surface ships, automobiles and trucks, railway vehicles, and magnetically levitated vehicles. *Preq:* M E 205, 305, or consent of instructor.
- M E 654 Design of Machine Elements 3(3,0)** Design of common machine elements including clutches, brakes, bearings, springs, and gears. Optimization techniques and numerical methods are employed as appropriate. *Preq:* M E 306 or consent of instructor.
- M E 655 Design for Computer-Automated Manufacturing 3(3,0)** Concepts of product and process design for automated manufacturing. Topics include product design for automated manufacturing, inspection and assembly using automation, industrial robots, knowledge-based systems, and concepts of flexible product manufacture. *Preq:* M E 301, 306, 404 (or concurrent enrollment) or consent of instructor.
- M E (E C E) 656 Fundamentals of Robotics 3(3,0)** Introduction to the fundamental mechanics and control of robots including their application to advanced automation. Topics include robot geometry, kinematics, dynamics, and control. Planar machine structures are emphasized, including methods using computer analysis. Application considerations include design and operation of robot systems for manufacturing and telerobotics. *Preq:* M E 305, 416 (or concurrent enrollment), or consent of instructor.
- M E 671 Computer-Aided Engineering Analysis and Design 3(2,3)** Students are exposed to geometric and solid modeling, finite elements, optimization, and rapid-prototyping. Students design an artifact, represent it on the computer, analyze it using FEA, then optimize before prototyping it. Emphasizes the use of computer-based tools for engineering design. *Preq:* ENGR 141, M E 202, or consent of instructor.
- M E 693 Selected Topics in Mechanical Engineering 1-6(1-6,0)** Study of topics not found in other courses. May be repeated for a maximum of six credits, but only if different topics are covered. *Preq:* Consent of instructor.
- M E 801 Foundations of Fluid Mechanics 3(3,0)** Derivations of basic equations for multidimensional flow fields; analytical techniques for solving problems in laminar viscous flow and laminar inviscid flow; theories of similitude. *Preq:* Consent of instructor.
- M E 810 Macroscopic Thermodynamics 3(3,0)** First, second, and third laws of thermodynamics with engineering applications; thermodynamic property relations; chemical equilibrium. *Preq:* M E 312 or equivalent.
- M E 811 Gas Dynamics 3(3,0)** Concepts from thermodynamics, one-dimensional gas dynamics, one-dimensional wave motion, normal, and oblique shocks; flow in ducts and wind tunnels; two-dimensional equation of motion; small perturbation theory. *Preq:* Undergraduate course in fluid mechanics.
- M E 812 Experimental Methods in Thermal Science 3(2,2)** Theories of measurements, instrumentation, and techniques for measuring temperature, pressure, and velocity on a practical graduate engineering level; mathematical presentation of data, uncertainty analysis, data acquisition techniques, and theory and state-of-the-art measuring systems.
- M E 814 Concepts of Turbulent Flow 3(3,0)** Concepts of fluid turbulence; turbulent transport mechanisms, dynamics of turbulence, and experimental techniques pertinent to existing theories; classification of shear flows and their prediction methods. *Preq:* M E 801.
- M E (PHYS) 815 Statistical Thermodynamics I 3(3,0)** See PHYS 815.
- M E 818 Introduction to Finite Element Analysis 3(3,0)** Introduction to the finite element method; applications to heat transfer, fluid flow and solids; introduction to transient analysis; analysis strategies using finite elements; introduction to solid modeling, finite element modeling and analysis using commercial codes. *Preq:* Numerical methods course or consent of instructor.
- M E 819 Computational Methods in Thermal Sciences 3(3,0)** Numerical techniques as applied to the solution of fluid flow and heat transfer problems; use of finite difference methods.
- M E 820 Modern Control Engineering 3(3,0)** Mathematical modeling of engineering systems using differential and difference state equations; state variable time solutions using analytic and computer-aided analysis techniques; state control principles of controllability, observability, stability and performance specification; trade-offs between state variable and transfer function techniques. *Preq:* Undergraduate controls course or consent of instructor.
- M E 821 Advanced Control Engineering 3(3,0)** Concepts in multivariable, nonlinear, stochastic, and optimal control engineering; design and analysis considerations related to physical machines and processes; mathematical methods as needed. *Preq:* Undergraduate controls course or consent of instructor.
- M E 822 Computer Control of Automated Machines 3(3,0)** Concepts for control of automated manufacturing machines, cells and processes; logic and switching control; programmable controllers; supervisory hierarchical and expert control systems concepts for manufacturing; closed-loop direct digital control design including sampling, stability and response of discrete system models; design and application of computer control algorithms; computer requirements; sensors and signal conversion. *Preq:* M E 820 or consent of instructor.
- M E 829 Energy Methods and Variational Principles 3(3,0)** Application of variational principles in solid mechanics problems; virtual work; Castigliano's theorems on deflection and rotation; stationary potential energy; energy stability criterion; Hamilton's principle. *Preq:* M E 837 or consent of instructor.
- M E 830 Conduction and Radiation Heat Transfer 3(3,0)** Fundamental concepts related to conduction and radiation heat transfer; analytical methods for steady and transient conduction heat transfer in one and two physical dimensions; radiation exchange between surfaces with and without radiatively participating media; combined conduction and radiation heat transfer. *Preq:* M E 304 or equivalent.
- M E 831 Convective Heat Transfer 3(3,0)** Derivation of continuity, momentum, and energy equations for boundary layer flow; solutions for confined and external flow regimes in laminar and turbulent flow. *Preq:* M E 304 or equivalent, MTHSC 208.
- M E 832 Radiative Heat Transfer 3(3,0)** Radiation properties; enclosure theory; radiation exchange between solid bodies; radiation exchange in the presence of absorbing, transmitting, and emitting media; combined radiation, conduction, and convection exchange. *Preq:* M E 304 or equivalent, consent of instructor.
- M E 833 Heat Transfer with Change of Phase 3(3,0)** Nucleate boiling in a pool; film boiling in a pool; forced nucleate boiling; forced film boiling; effect of impurities on boiling phenomena; dropwise condensation; filmwise condensation; effect of noncondensable gases on condensation; boiling and condensing processes in systems. *Preq:* M E 304 or equivalent, consent of instructor.
- M E 834 Principles of Structural Stability 3(3,0)** Practical criteria for analysis of conservative and nonconservative systems' stability; methods of adjacent equilibrium, initial imperfections, total potential energy, and vibration as applied to practical problems. *Preq:* M E 837.
- M E 836 Fracture Mechanics 3(3,0)** Fundamental elasticity-based course in the development of the basic concepts of engineering fracture mechanics; the Griffith criterion, Barrenblatt and Dugdale models, linear elastic fracture mechanics (L.E.F.M.), plane strain fracture toughness, the crack-tip stress and strain field, and plasticity and the J-integral. *Preq:* M E 837.
- M E 837 Theory of Elasticity I 3(3,0)** Theory of stress and deformation for continuous media; linear stress-strain relations for elastic material; two-dimensional problems including Airy stress function, polynomial solutions, plane stress and plane strain in rectangular and polar coordinates, torsion and bending of prismatic bars and thermal stresses. *Preq:* M E 302, MTHSC 208.
- M E 838 Theory of Elasticity II 3(3,0)** Continuation of M E 837 including topics from either three-dimensional problems associated with an infinite elastic medium, elastic half-space, contact stresses, symmetrically loaded sphere and circular cylinder, or complex variable methods in plane elasticity, stress concentrations problems, singular stresses and fracture, and composite materials. *Preq:* M E 837, PHYS 812.

**M E 843 Nonlinear Dynamics of Mechanical Systems 3(3,0)** Behavior of nonlinear mechanical systems analyzed with numerical, graphical, and analytical methods; understanding nonlinear effects and methods of analysis. *Preq:* Graduate standing or consent of instructor.

**M E 844 Random Vibration: Theory and Measurement 3(3,0)** Analysis and measurement of random phenomena; description of random phenomena (probability theory, response of systems to random phenomena, and digital signal processing theory); use of spectrum analyzer and other digital signal recording instruments. *Preq:* M E 302 or MTHSC 208 and consent of instructor.

**M E 845 Vibration of Continuous Media 3(3,0)** Fundamental principles of generation, propagation, absorption, reflection, and scattering of vibrational wave in solids and fluids; free and forced oscillation of flexible strings, bars, membranes, and plates; theory of wave motion in liquids and gases. *Preq:* Consent of instructor.

**M E 846 Intermediate Dynamics 3(3,0)** Kinematics and dynamics of particles and rigid bodies, Lagrange and Hamilton's formulation of mechanics; two-body central force problem; rendezvous of two bodies in a central force field; rotation of rigid bodies about a fixed point in space; vector analysis and matrix methods as aids in mathematical analysis. *Preq:* E M 202 or consent of instructor.

**M E 852 Advanced Finite Element Analysis 3(3,0)** Application of variational and weighted residuals methods; nonlinear analysis, steady-state, and time-dependent problems; application of commercial finite element codes; advanced computational procedures. *Preq:* C E 808 or equivalent or consent of instructor.

**M E (E C E) 854 Analysis of Robotic Systems 3(3,0)** See E C E 854.

**M E (E C E) 859 Intelligent Robotic Systems 3(3,0)** See E C E 859.

**M E 861 Materials Selection in Engineering Design 3(3,0)** Advanced study of various physical, chemical, and mechanical materials properties which govern the selection of materials in engineering design. Case studies of materials selection in design with metals, ceramics, polymers, and composites are presented.

**M E 870 Advanced Design Methodologies 3(3,0)** Nurturing of creativity; decision-making processes for design; in-depth study of the mechanical design process and tools; quality function deployment, concurrent design, systemic design, robust design, design for assembly, and axiomatic design.

**M E 871 Engineering Optimization 3(3,0)** Optimization in the context of engineering design; nonlinear and linear, static and dynamic, constrained and unconstrained formulation and solution of practical problems; structural optimization; multiobjective optimization; genetic algorithms; simulated annealing.

**M E 891 Master's Thesis Research 1-12**

**M E 893 Selected Topics in Mechanical Engineering 1-6(1-6,0)** Topics not covered in other courses. May be repeated for credit.

**M E 930 Advanced Topics in Heat Transfer 1-6(1-6,0)** Topics not covered in other courses. May be repeated for a maximum of six credits.

**M E 931 Advanced Topics in Fluid Mechanics 3(3,0)** Topics not covered in other courses. May be repeated for a maximum of six credits.

**M E 932 Advanced Topics in Thermodynamics 3(3,0)** Topics not covered in other courses. May be repeated for a maximum of six credits.

**M E 991 Doctoral Dissertation Research 1-12**

## MICROBIOLOGY

**MICRO 600 Public Health Microbiology 3(3,0)** Epidemiology of transmissible diseases including pathogenic characteristics of the infectious organism, modes of transmission, mechanism of infection, diagnostic aids, effective treatments, immunizing procedures, and methods of preventing infection. *Preq:* MICRO 305.

**MICRO 601 Microbial Diversity and Ecology 4(2,6)** In-depth survey of microbial morphology, ecology, and diversity. Study of the interaction and adaptation of microbes in a wide range of environmental conditions, including consideration of their metabolism, nutrition, growth, and the use of microbiological assays. *Preq:* CH 201 or 223, 227, MICRO 305.

**MICRO 603 Marine Microbiology 3(2,3)** Discussion of the microbes that inhabit the marine environment, their peculiar physiological traits, and contributions to the ecology of oceans. *Preq:* MICRO 305, organic chemistry.

**MICRO 607 Food and Dairy Microbiology 4(3,3)** Physical-chemical factors limiting survival and growth of microorganisms during processing and manufacturing of food and dairy products. Standard methods for enumerating and identifying indicator bacteria, yeasts, molds, and microbes producing food and food-borne illness. Starter cultures, fungal toxins, microbial cell injury, and standards for food and dairy products. *Preq:* BIOCH 305 or CH 201 or 223, MICRO 305.

**MICRO 610 Soil Microbiology 3(2,3)** Role of microorganisms in the decomposition of organic substances, transformation of nitrogen, and mineral substances in the soil; interrelationships between higher plants and microorganisms; importance of microorganisms in soil fertility. *Preq:* MICRO 305.

**MICRO 611 Pathogenic Bacteriology 4(3,3)** Study of pathogenic bacteria, their morphology, cultural requirements, and classification; diagnostic tests, methods of differentiation, and the diseases caused. *Preq:* MICRO 305.

**MICRO 612 Bacterial Physiology 4(3,3)** Consideration of the cytology, physiology, metabolism, and genetics of bacteria including growth and death, reproduction and mutation, nutrition and metabolic pathways, regulatory mechanisms, and effects of environment. *Preq:* CH 224, MICRO 305, one semester of biochemistry, or consent of instructor.

**MICRO 613 Industrial Microbiology 3(2,3)** Microbial aspects of large-scale processes for the production of foods, antibiotics, enzymes, fine chemicals, and beverages. Topics include strain selection, culture maintenance, biosynthetic pathways, continuous cultivation, and production of single cell protein. *Preq:* MICRO 305.

**MICRO (AVS, BIOSC) 614 Basic Immunology 4(3,3)** Consideration of the nature, production, and function of basic immune responses in animals. Procedures and mechanisms of antigen-antibody and other immune reactions. *Preq:* MICRO 305, organic chemistry.

**MICRO 615 Microbial Genetics 4(3,3)** Cytological basis of bacterial, fungal, and viral genetics; molecular aspects; mutations; mechanisms of genetic transfers; episomes and plasmids; and population changes. *Preq:* BIOCH 301, CH 224, MICRO 305, or consent of instructor.

**MICRO 616 Introductory Virology 3(3,0)** General introduction to the field of virology including animal, bacterial, and plant viruses. Topics include nomenclature and classification, biochemical and biophysical characteristics, mechanisms of replication, chemotherapy, and techniques for isolation, assay, and purification. *Preq:* BIOCH 301, MICRO 305, or consent of instructor.

**MICRO 617 Molecular Mechanisms of Carcinogenesis and Aging 3(3,0)** Changes which occur at the cellular and subcellular levels during transformation and aging. Accumulated damage and "intrinsic clock" theories of aging; genetic and epigenetic theories of carcinogenesis; epidemiology of cancer; viral, radiation-induced, and chemical carcinogenesis; the immune system and cancer. *Preq:* BIOCH 301, MICRO 305, or consent of instructor.

**MICRO (BIOSC, GEN) 618 Biotechnology I: Nucleic Acids Techniques 4(2,4)** See GEN 618.

**MICRO 619 Selected Topics in Molecular Medicine 3(3,0)** Introduction to various areas of molecular medicine. Examines the latest research and developments in molecular medicine. Designed for students interested in medicine and biomedical research. May be repeated for a maximum of six credits. *Preq:* BIOCH 301, MICRO 305, or consent of instructor.

**MICRO 802 Bacteriological Techniques 4(2,6)** Analytical and experimental procedures used in bacteriology including techniques for studying bacterial cytology, physiology, and metabolism; experience in more advanced methods of investigation. Offered fall semester only.

**MICRO 803 Special Problems in Microbiology 1-3** Research not related to a thesis.

**MICRO 804 Selected Topics in Microbiology 1-3(1-3,0)** Evaluation of current research literature in various areas of microbiology. Critical evaluation of specific publications in terms of their scientific merit. Required of all Microbiology graduate students. May be repeated for credit.

**MICRO 805 Techniques of Clinical Microbiology and Immunobiology 3(2,3)** Methods for isolating, identifying, and culturing different mammalian cell types; techniques used to analyze cell function and viability and for protein and DNA analysis emphasizing application to the diagnosis of disease, determination of prognosis, optimization of treatment, and determination of etiology. *Preq:* MICRO (AVS, BIOSC) 614, 615, BIOCH 623 or equivalent, or consent of instructor.

**MICRO 806 Pathogenesis and Infectious Disease 3(3,0)** Medically important host-parasite relationships at the cellular and subcellular levels with emphasis on bacterial and viral infections in man. *Preq:* MICRO 611 or consent of instructor.

**MICRO 807 Seminar 1(1,0)** Topics not covered in other courses. Students review literature, organize, and present material. May be repeated for a maximum of two credits.

**MICRO 808 Biotechnology and Medicine 3(3,0)** Medical problems currently receiving attention due to the application of biotechnology to diagnosis or treatment. Basic information essential to understanding the molecular biology of the disease and its diagnosis or treatment. *Preq:* Consent of instructor.

**MICRO (HLTH) 809 Epidemiological Research 3(3,0)** Basic concepts of epidemiology with emphasis on applied aspects rather than theoretical. Examples are drawn from clinical practice. Use of relevant PC-based computer packages is required. *Preq:* MTHSC 405 or EX ST 801 or consent of instructor.

**MICRO 811 Bacterial Cytology and Physiology 4(4,0)** Structure, chemistry, and physiology of the various bacterial cell components. Physiology of bacterial growth and reproduction in batch, continuous, and synchronous cultures. Economy of the bacterial cell including endogenous metabolism and maintenance requirements; physiology of bacterial death; regulation of enzyme and nucleic acids syntheses. Offered spring semester of odd-numbered years only. *Preq:* BIOCH 423, MTHSC 206, or consent of instructor.

**MICRO 812 Bacterial Metabolism 3(3,0)** Various biochemical pathways occurring in bacterial cells; fermentations of carbohydrates and related compounds and of nitrogenous organic compounds; anaerobic and aerobic respiration including electron transport systems and oxidative phosphorylation; bacterial photosynthesis; nitrogen fixation; biosyntheses of amino acids, purines, pyrimidines, lipids, proteins, nucleic acids, and polysaccharides. Offered spring semester of even-numbered years only. *Preq:* BIOCH 423, MTHSC 206, or consent of instructor.

**MICRO 815 Advanced Microbial Genetics 3(3,0)** Current developments in microbial genetics; integration of genetics and biochemistry; analysis of genetic fine structure in microorganisms; nature of bacterial variation and expression of mutations; population dynamics; physicochemical mechanisms of heredity; regulation of gene action in microorganisms; physiology and genetics of virulent and lysogenic bacteriophages. Offered fall semester only. *Preq:* MICRO 415.

**MICRO 891 Master's Thesis Research 1-12**

**MICRO 991 Doctoral Dissertation Research 1-12**

## MUSIC

**MUSIC 600 Elementary Music in the Classroom 3(3,0)** Familiarizes teachers in the elementary classroom with traditional Kodaly, Orff, and Kindermusik approaches in correlating music with language arts, mathematics, and social studies.

**MUSIC 680 Audio Engineering II 3(2,2)** Advanced course in music technology focused on music production integrating digital audio and virtual instruments *Preq:* MUSIC 380 or consent of instructor.

**MUSIC 699 Independent Studies 1-3(1-3,0)** Tutorial work for students with special interests in music study outside the scope of existing courses. May be repeated for a maximum of six credits. *Preq:* Consent of department chair.

## NURSING

**NURS 801 Advanced Family and Community Nursing 3(3,0)** Developmental, psychodynamic, social-political, and cultural theories and concepts are synthesized and applied to the analysis of health and illness in communities and in families across the life cycle. Roles and functions of advanced practice nurses in promoting community health and family health are examined.

**NURS 804 Knowledge Development in Advanced Nursing 2(2,0)** Nursing theories and theories relevant to nursing practice and research; processes of theoretical thinking and critical thinking applied to health problems and needs of individuals and their families in the community; theoretical and conceptual models of contemporary practice and research.

**NURS 805 Pharmacotherapeutics for Advanced Nursing 3(3,0)** Prescription administration and patient/family education in use of pharmacological agents emphasizing drugs prescribed for common or chronic illnesses; drug selection; adverse drug reactions; age-related differences in utilization; regulations affecting nurses' prescriptive authority. *Preq:* NURS 809 or consent of instructor.

**NURS 806 Advanced Assessment for Nursing 2(1,3)** Comprehensive assessment and diagnosis of health problems and status for individuals of all ages including assessment of families; physical and laboratory/radiologic diagnostic assessments; directed laboratory experiences in advanced assessment of clients of several ages. *Preq:* Undergraduate assessment and NURS 809 or consent of instructor.

**NURS 807 Clinical Nursing Research 2(2,0)** Quantitative and qualitative research methodologies useful and appropriate to clinical nursing practice and for the development of nursing knowledge; ethics with human subjects; does not include thesis advisement. Student must select chairperson prior to enrollment. *Preq:* NURS 804, 808.

**NURS 808 Nursing Research Analysis 2(2,0)** Quantitative research methods in nursing science including basic elements of statistical design with a focus on the use of nursing informatics and computer applications. *Preq:* Undergraduate statistics course.

**NURS 809 Pathophysiology for Advanced Nursing 2(2,0)** Human response to health alterations as they impact nursing knowledge and practice; recognizing the manifestations of health alterations and developing nursing interventions accordingly.

**NURS 819 Developing Family Nursing 4(2,6)** Theories and concepts related to nursing management in the care of developing families; critical thinking applied to health problems and needs of developing families before, during, and immediately following pregnancy; application of related nursing issues and current research; clinical practice with developing families in a variety of settings. *Preq:* NURS 801, 804, 805, 806, 809.

**NURS 820 Child and Adolescent Nursing 4(2,6)** Advanced nursing roles and functions applied to health promotion, health maintenance, health restoration, habilitation, and rehabilitation of infants, children, and adolescents with existing or potential health problems. Critical thinking is used to assess, diagnose, intervene, and promote continuity of care with clients of these ages irrespective of setting. *Preq:* NURS 801, 804, 805, 806, 809.

**NURS 821 Adult Nursing 4(2,6)** Roles and functions embodied in advanced practice applied to the health promotion and clinical management of common or chronic health problems of adults within the context of family; clinical practice with adult clients in a variety of settings. *Preq:* NURS 801, 804, 805, 806, 809.

**NURS 822 Gerontology Nursing 4(2,6)** Roles and functions of advanced practice applied to the preventive, restorative, and rehabilitative care of the older adult with existing or potential health problems; clinical practice in a variety of settings. *Preq:* NURS 801, 804, 805, 806, 809.

**NURS 823 Nurse Practitioner Clinical Practicum 6(0,18)** Guided practice applying advanced nursing knowledge in family nursing and advanced practice roles (clinical nurse specialist, case manager, and/or practitioner); joint preceptor and faculty guidance and supervision in the care of selected populations in a variety of health care settings. *Preq:* FNP track: NURS 819, 820, 821, 822; GNP track: NURS 822, 882, 884; A/GNP track: NURS 821, 822, 882, 884.

**NURS 825 Theories and Models of Nursing Administration 3(3,0)** Identification, analysis, and synthesis of theories, models, and issues related to nursing management and leadership; organization, attitudes, and practices applicable to the middle and executive levels of nursing administration. *Preq:* NURS 804.

**NURS 826 Administration of Nursing Services 3(2,3)** Application of theories and models to specific nursing administration issues and problems. Practicum in nursing administration at the middle or executive level permits specific use and evaluation of a conceptual model of nursing administration. *Preq:* NURS 825.

**NURS 827 Foundations of Nursing Education 3(3,0)** Exploration of the foundations of nursing education. Emphasizes curriculum development in nursing for the collegiate or continuing education areas. Current issues and research that influence nursing education. *Preq:* Graduate standing in Nursing.

**NURS 828 The Nurse Educator 3(2,3)** Roles and functions of nurse educators applied to education of nurses and nursing students in collegiate and continuing education nursing education programs; current issues and research in classroom, laboratory, and continuing education programs. A teaching practicum is required. *Preq:* NURS 827 or consent of instructor.

**NURS 829 Theories and Models of Clinical Specialization 3(3,0)** Caregiver, researcher, manager, teacher, and consultant roles of the clinical nurse specialist in a variety of settings; theories, models, and health care issues underlying the role of clinical nurse specialist. *Preq:* NURS 804, CNS graduate option, or consent of instructor.

**NURS 830 Clinical Specialty Practicum in Nursing 6(0,18)** Advanced practice in a selected clinical specialty area in nursing that emphasizes application of the clinical specialist role. *Preq:* NURS 829 and one of the following: NURS 819, 820, 821, 822, 882, 884, or consent of instructor.

**NURS 831 Clinical Research Problems 1-3(1-3,0)** Critical thinking and methodologies of scientific inquiry applied to clinical issues/problems encountered in advanced nursing practice. May be repeated for a maximum of three credits. To be taken Pass/Fail basis. *Preq:* NURS 804.

**NURS 846 Healthcare Financial Management 3(3,0)** Financial management theory and practice for nurse executives; the state of financial reporting requirements and accounting practices for decision-making and operating activities; processes for measuring and reporting financial information and analysis; interpretation and use of accounting information for planning and controlling the health care business. *Preq:* Undergraduate accounting.

**NURS 847 Internship 3(1,6)** Guided practice to apply advanced nursing knowledge in nursing administration in the advanced practice role; joint preceptor and faculty guidance and supervision in the administrative management and care with selected populations in a variety of health care settings. *Preq:* NURS 825, 826, 846, or consent of instructor.

**NURS 848 Health Care Policy and Economics 3(3,0)** Reciprocal relationship between client, community, health care system, sociocultural, and economic variables and policy making; analysis and synthesis of these relationships and their impact on the role and responsibility of the advanced practice nurse and nurse administrator. *Preq:* Graduate standing or consent of instructor.

**NURS 850 Information and Control Systems for Nursing Leadership 3(3,0)** Computer-based systems of information management and control for nursing environments. Explores data needed for cost-efficient use of nursing resources and effective systems of monitoring, quality assurance, and control; information systems as tools useful to humanistic nursing practice, human resource management, and solution of professional and scientific problems. *Preq:* Graduate standing or consent of instructor.

**NURS 879 Special Topics in Nursing 1-3(1-3,0-9)** In-depth seminar on selected topics such as therapeutic communication, legal and ethical issues in nursing, and health care and political process in health. *Preq:* Consent of instructor.

**NURS 882 Primary Care for Elders 4(2,6)** Application of the roles and functions of advanced practice in the management of frailty in old age; prevention of early disability and dependence; maintenance of function, independence, and self care; cultural, social, and ethical issues. *Preq:* NURS 801, 804, 805, 806, 809.

**NURS 884 Mental Health and Illness of Adults 4(2,6)** Psychosocial, developmental, spiritual, and cultural theories are synthesized and applied to the analysis of mental health and illness in adulthood. Considers roles and functions of advanced practice nurses in promoting the mental health of adults and their families. Clinical practice in the community is incorporated. *Preq:* NURS 801, 804, 805, 806, 809.

**NURS 889 Special Problems in Nursing 1-6(1-6,0)** Problems selected to meet special and individualized interests of students. Up to six hours of NURS 889 may be taken as elective credit. *Preq:* Consent of instructor.

**NURS 891 Master's Thesis Research 1-12** Research activities related to thesis; minimum of six hours required. *Preq:* NURS 804.

## NUTRITION

**NUTR 601 Fundamentals of Nutrition 3(3,0)** Biochemical and physiological fundamentals of nutrition applicable to domestic animals and man. Digestive processes and absorption and metabolism of carbohydrates, lipids, proteins, water, minerals, and vitamins are considered. Energy metabolism and comparative anatomy and physiology of digestive systems are discussed. Offered fall semester only. *Preq:* BIOCH 305, CH 223, or consent of instructor.

**NUTR 624 Medical Nutrition Therapy I 4(3,3)** Principles of nutritional assessment, education, and counseling skills; development of medical nutrition therapy for individuals with obesity and eating disorders, gastrointestinal disorders, metabolic, and renal disorders. *Preq:* BIOSC 223, NUTR 451, or consent of instructor.

**NUTR 625 Medical Nutrition Therapy II 4(3,1)** Development of medical nutrition therapy for individuals with various disease states including cardiovascular, hepatic, musculoskeletal, and neoplastic disorders with consideration of socio-cultural and ethnic aspects of food consumption and alternative nutrition therapies. *Preq:* BIOSC 223, NUTR 424, or consent of instructor.

**NUTR 626 Community Nutrition 3(3,0)** Study of fundamentals of nutrition care delivery in community programs beginning with assessment and problem identification and continuing through the development, implementation, and evaluation of nutrition intervention programs. *Preq:* NUTR 451 or equivalent or consent of instructor.

**NUTR 651 Human Nutrition 3(3,0)** Essentials of nutrition and principal nutritional deficiency conditions. Factors affecting adequacy of dietary intake, methods of determining nutritional status, development of nutrition standards, and recent advances in human nutrition. *Preq:* BIOCH 305/306 or equivalent or consent of instructor.

**NUTR 655 Nutrition and Metabolism 3(3,0)** Concepts of metabolism fundamental to understanding normal and therapeutic nutrition are examined. Bioenergetics as well as metabolism of carbohydrates, lipids, amino acids, vitamins, and minerals as they relate to nutrition are discussed. *Preq:* BIOCH 305 or 406 or 423, NUTR 451, or consent of instructor.

**NUTR 706 Nutrition for Teachers 3(3,0)** Principles of nutrition applied to nutrition education. *Preq:* Consent of instructor.

**NUTR 801 Topical Problems in Nutrition 1-3(1-3,0)** Topics not covered in other courses or by thesis research. Credit varies with problems selected.

**NUTR 802 Special Topics in Nutrition 1-3(1-3,0)** Topics of special interest or contemporary subjects not examined in other courses.

**NUTR 803 Advanced Human Nutrition 4(4,0)** Biochemistry and physiology related to human nutrition and their application to formation and adoption of healthy eating patterns. Emphasis is on individual nutrients in the context of healthy eating patterns throughout the life cycle and on recent advances in human nutrition. *Preq:* BIOCH 305/306, BIOSC 223, NUTR 451, or consent of instructor.

**NUTR 804 Nutrition Education of the Public 3(3,0)** Analysis of community-based food and nutrition programs to include management, program provision, outcome-based evaluation, and integration of services. Emphasis is on outcome-based nutrition education across the lifespan, management and integration of multiple services for targeted population, and public policy development. *Preq:* NUTR 426 or consent of instructor.

**NUTR 805 Metabolic Basis of Medical Nutrition Therapy 3(3,0)** Integration of metabolism and pathophysiology into medical nutrition therapy recommendations. *Preq:* NUTR 425 or consent of instructor.

**NUTR 806 Dietetic Internship 1-6(0,3-18)** Internship consisting of preceptor-supervised and faculty-led dietetic experiences in community, clinical, and food service settings. Must be taken for six credits during the internship rotations. *Preq:* Acceptance into Dietetic Internship Program.

**NUTR 808 Monogastric Nutrition 3(3,0)** Basic concepts and current research related to nutrient requirement and metabolism of poultry, swine, and other monogastric species. *Preq:* NUTR 401 or 451.

**NUTR 809 Ruminant Nutrition 3(3,0)** Microbiological, biochemical, and physiological processes involved in the synthesis of amino acids, proteins, and B-vitamins; relation of these processes to utilization of proteins, lipids, and fibrous and nonfibrous feed ingredients; properties and functions of nutrients, nonprotein nitrogen compounds, and growth-promoting substances for dairy cattle, beef cattle, and sheep. *Preq:* NUTR 401 or consent of instructor.

**NUTR 811 Carbohydrate Nutrition 2(2,0)**

Dietary sources, chemistry, absorption/excretion, and functions of carbohydrates; the aberrations of metabolism and possible role in the etiology of degenerative diseases. *Preq:* BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or consent of instructor.

**NUTR 817 Mineral Nutrition 2(2,0)**

Occurrence, chemistry, absorption/excretion, and general and specific physiological functions of minerals. *Preq:* BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or consent of instructor.

**NUTR 819 Vitamin Nutrition 2(2,0)**

Overview of the chemistry, metabolism, physiology, digestion, absorption, and excretion of the vitamins as applied to the nutrition of humans and domestic animals. *Preq:* BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or consent of instructor.

**NUTR 820 Nutritional Bioenergetics 2(2,0)**

Quantitative approach to the losses of dietary energy during digestion and metabolism; factors governing the energetic efficiency of different biological functions in animals and man; regulation of energy balance; body temperature regulation; techniques of calorimetry. *Preq:* BIOCH 623 or equivalent; NUTR 601 or 651 or equivalent; or consent of instructor.

**NUTR 851 Nutrition Seminar I 1(1,0)**

Current research and developments in nutrition. Topics, selected by the instructor and students, come from student research and nutrition literature. Offered fall semester only.

**NUTR 852 Nutrition Seminar II 1(1,0)**

Continuation of NUTR 851. Offered spring semester only.

**NUTR 891 Master's Thesis Research 1-12****NUTR 991 Doctoral Dissertation Research 1-12****PACKAGING SCIENCE****PKGSC 601 Packaging Machinery 3(3,0)**

Systematic study of types of machinery used to form, fill, seal, and handle various packages, products, and packaging materials. Emphasizes basic mechanical, electrical, pneumatic, and hydraulic components of packaging machinery along with packaging machinery terminology. Discusses methods for machine line optimization and layout. *Preq:* PKGSC 204, PHYS 207, or consent of instructor.

**PKGSC 604 Mechanical Properties of Packages and Principles of Protective Packaging 3(3,0)**

Study of mechanical properties of products and packages and standard methods of determining these properties. Focuses on the functional properties of packages related to shock and vibration isolation and compression. *Preq:* PHYS 207, MTHSC 106, PKGSC 204, or consent of instructor.

**PKGSC 616 Application of Polymers in Packaging 4(3,3)**

Detailed study of polymer science and engineering as applied to packaging science. Includes polymer morphology, rheology, physical properties, processing methods, and polymerization. Emphasizes relationships among processing, structure, and properties. *Preq:* PKGSC 204, 206; CH 201 or 223; PHYS 207; or consent of instructor.

**PKGSC 620 Package Design and Development 3(2,3)**

Study of principles and methods practiced in designing and developing packages and packaging systems and of methods used to coordinate and analyze package development activities including interfacing with product development, manufacturing, marketing, purchasing, and accounting. *Preq:* PKGSC 368, 401, 404, 416, 464, or consent of instructor; second semester senior standing.

**PKGSC 630 Converting for Flexible Packaging 3(1,6)**

Study of materials, methods, processes, and equipment used in converting web materials for flexible packaging. Laboratory provides hands-on experience preparing and operating pilot-scale converting equipment. *Preq:* PKGSC 204, 206; or consent of instructor.

**PKGSC 640 Packaging for Distribution 3(3,0)**

Packages are exposed to various shipping methods and numerous hazards during distribution. To ensure adequate product protection, packaging professionals need to understand the fundamental principles of distribution packaging design. Topics include ASTM and ISTA packaging test methods, packaging design guidelines for distribution, terminology, transport modes, distribution hazards, and protective packaging materials. *Preq:* PKGSC 454 or consent of instructor.

**PKGSC 654 Product and Package Evaluation Laboratory 1(0,3)**

Laboratory experiments to determine properties of packaging materials and to evaluate the response of packages and products to shock, vibration, and compression. Students operate standard testing equipment and become familiar with industry-recognized test methods and standards. *Preq:* PKGSC 404 (or concurrent enrollment).

**PKGSC 664 Food and Health Care Packaging Systems 4(3,3)**

Characteristics, engineering properties, and applications of various materials and systems used in the packaging of foods, pharmaceuticals, and medical devices. Packaging systems for specific food and medical applications are considered. Laboratory and field exercises on food and medical packaging operations and packaging materials are included. Emphasis is on evaluation methods. *Preq:* PKGSC 201, 204, 206, or consent of instructor.

**PKGSC 671 Wood and Paper Packaging 3(3,0)**

In-depth study of use of wood and paper in packaging. Covers characterization of raw materials, basic conversion processes, and the use of converted products in packaging. Emphasizes the relationship between structure, processing, and properties. *Preq:* PKGSC 102 or consent of instructor.

**PKGSC 802 International Packaging 3(3,0)**

International packaging, including material, practices, machinery, marketing, and regulatory compliance principles. *Preq:* Consent of instructor.

**PKGSC 804 Flexible Packaging 3(2,3)**

In-depth study of flexible, plastic-containing primary packages and the methods and materials used to manufacture them. Six representative packages are selected for discussion using a case-study approach. Guest lecturers and plant visits illustrate and amplify the primary instructional materials. *Preq:* PKGSC 416 and 471 or consent of instructor.

**PKGSC 806 Semi-Rigid Packaging 3(2,3)**

Semi-rigid and rigid plastic-containing primary packages and containers and the methods and materials used to manufacture them. Six representative packages are selected for discussion using a case-study approach. Guest lectures and plant visits are used to amplify and illustrate the primary instructional materials. *Preq:* PKGSC 416 and 471 or consent of instructor.

**PKGSC 821 Selected Problems 1-4(0,1-12)**

Independent research investigations in packaging science related to packaging materials, machinery, design, and applications in areas not covered in other courses. May be repeated for credit. *Preq:* Consent of instructor.

**PKGSC 822 Selected Topics 1-4(1-4,0)**

Selected topics in packaging science not covered in detail or contained in other courses. May be repeated for credit. *Preq:* Consent of instructor.

**PKGSC 851 Packaging Science Seminar 1(1,0)**

Current research and related developments in packaging science reviewed by faculty, students, and invited lecturers. May be repeated for a maximum of four credits. *Preq:* Consent of instructor.

**PKGSC 891 Master's Thesis Research 1-9**

Research on a master's thesis topic.

**PARKS, RECREATION, AND TOURISM MANAGEMENT****PRTM 612 Therapeutic Recreation and Mental Health 3(3,0)**

Therapeutic recreation services in mental health clinics, institutions, and outdoor settings. Review of disorders and current modes of treatment as they relate to therapeutic recreation. *Preq:* PRTM 311, 2.0 cumulative grade-point ratio, consent of instructor.

**PRTM 621 Recreation Financial Resources Management 3(3,0)**

Analysis of recreation financial resources management. Deals with revenue sources and their allocation. *Preq:* PRTM 321, Senior standing in Parks, Recreation, and Tourism Management, 2.0 cumulative grade-point ratio.

**PRTM (GEOG) 630 World Geography of Parks and Equivalent Reserves 3(3,0)**

Major international patterns in the provision and use of urban and rural parks and recreation are examined. *Preq:* 2.0 cumulative grade-point ratio.

**PRTM 631 Methods of Environmental Interpretation 3(2,3)**

Practice and instruction in the use of equipment and methods available to the interpreter in public contact work. Coaching in presentation and evaluation of live programs and in design, execution, and evaluation of mediated programs is the major emphasis. Programs are delivered to public audiences in the Clemson area. *Preq:* PRTM 330; Senior standing in Parks, Recreation, and Tourism Management; 2.0 cumulative grade-point ratio; consent of instructor.

**PRTM 641 Commercial Recreation 3(3,0)**

Components of offering leisure services and products to the public by individuals, partnerships, and corporations for the purpose of making a profit. *Preq:* 2.0 cumulative grade-point ratio.

**PRTM 643 Resorts in National and International Tourism 3(3,0)** A variety of resort types are studied with respect to their development, organization, visitor characteristics, and environmental consequences. A case-study approach is used. *Preq:* 2.0 cumulative grade-point ratio.

**PRTM 644 Tour Planning and Operations 3(3,0)** Provides the opportunity to understand the psychology of touring with emphasis on packaged and group tours and how tours of different types and scale are planned, organized, marketed, and operated. *Preq:* PRTM 342, 2.0 cumulative grade-point ratio, consent of instructor.

**PRTM 645 Conference/Convention Planning and Management 3(3,0)** Provides the opportunity to understand the problems of and solutions to conference and convention planning and management from both the sponsoring organization's and facility manager's perspectives. *Preq:* 2.0 cumulative grade-point ratio.

**PRTM 646 Community Tourism Development 3(3,0)** Provides a community-based perspective of the organizational, planning, development, and operational needs for a successful tourism economy at the local level. *Preq:* PRTM 342, 2.0 cumulative grade-point ratio, consent of instructor.

**PRTM 647 Perspectives on International Travel 3(3,0)** Using the United States as a destination, international travel patterns and major attractions are presented. Factors that restrain foreign travel to the United States are analyzed. *Preq:* 2.0 cumulative grade-point ratio.

**PRTM 652 Campus Recreation 3(3,0)** Study of the basic components required for administration of successful college union and intramural-recreation sport programs. *Preq:* 2.0 cumulative grade-point ratio.

**PRTM 801 Philosophical Foundations of Recreation and Park Administration 3(3,0)** Current theories and philosophies in recreation as they are influenced by and have influence on leisure and the changing environment in America. Students develop their own professional philosophies of recreation and leisure.

**PRTM 802 Group Processes in Leisure Services 3(3,0)** Improvement in human relations skills; knowledge of interpersonal needs and problems of individuals and groups. Students gain understanding of how others affect them and how they affect others and become more effective professional recreators, park administrators, supervisors, interpreters, and educators.

**PRTM 803 Seminar in Recreation and Park Administration 3(3,0)** Case problems relating to administration of a park, recreation, or tourism agency.

**PRTM 804 Independent Study 1-3(1-3,0)** Topics in recreation, leisure, and tourism not covered in other courses. Written report of findings is required. May be repeated for a maximum of three credits. *Preq:* Consent of supervising faculty prior to registration.

**PRTM 805 Internship 1-3** Field placement in an approved agency under qualified supervision. To be taken Pass/Fail only. *Preq:* PRTM major or consent of instructor.

**PRTM 806 Special Problems 1-3(1-3,0)** Directed, individual comprehensive investigation of a special problem to use knowledge gained in formal courses, provide experience and training in research, and prepare for professional goals. Report of findings is required. May be repeated with a maximum of three credits applied toward graduation requirements. To be taken Pass/Fail only.

**PRTM 807 Recreation Behavior in Natural Environments 3(3,0)** Social, psychological, and environmental influences on human behavior; identification of theoretical perspectives to explain behavior and to resolve problems in recreation resource management.

**PRTM 808 Behavioral Aspects of Parks, Recreation, and Tourism Management 3(3,0)** Behavioral aspects of recreation, focusing on the social and psychological dimensions of the recreation experience in a variety of environments and activities.

**PRTM 811 Research Methods in Parks, Recreation, and Tourism Management 3(3,0)** Principles, methods, and strategies for planning, designing, evaluating, and applying studies of recreation. *Preq:* Graduate-level statistics course or consent of instructor.

**PRTM 812 Leisure Services for the Elderly 3(3,0)** The elderly and the role of leisure services in later life; needs of community-based and institutionalized elderly; service delivery systems to meet these needs.

**PRTM (FOR) 816 Remote Sensing and GIS in Natural Resources 3(2,3)** See FOR 816.

**PRTM 820 Recreation Resource Policy Issues and Processes 3(3,0)** Outdoor recreation policy-formation structures and processes are surveyed through case studies involving past and current public policy issues.

**PRTM 840 Tourism Planning 3(3,0)** Tourism planning procedures and techniques; planning process and associated concerns such as market, facility, infrastructure, environment, culture, and economics.

**PRTM 843 Tourism Analysis 3(3,0)** Selected theories, methods, techniques, practices, and principles that govern tourism behavior. *Preq:* Graduate standing or one graduate-level statistics course or consent of instructor.

**PRTM (C R P) 844 Outdoor Recreation Resource Management and Planning 3(3,0)** See C R P 844.

**PRTM 881 Therapeutic Recreation Theories and Concepts 3(3,0)** Provides students with the opportunity to analyze critically the philosophical positions influencing service delivery and the theories underlying therapeutic recreation practice models and service delivery. *Preq:* PRTM 880 or undergraduate degree in Parks, Recreation, and Tourism Management.

**PRTM 891 Master's Thesis Research 1-12**

**PRTM 900 Selected Topics 1-3(1-3,0)** In-depth, timely study of trends or problems in parks, recreation, and tourism not covered in other courses. May be repeated for a maximum of six credits.

**PRTM 908 Advanced Topics 1-3(1-3,0)** Topics not covered in other PRTM courses and not directly related to a thesis or dissertation topic. Formal paper is required. May be repeated for a maximum of six credits. *Preq:* Consent of instructor.

**PRTM 910 Research Seminar 1(1,0)** Current research developments in PRTM and presentation of research projects. May be taken for credit for two semesters. To be taken Pass/Fail only.

**PRTM 911 Professional Issues in Parks, Recreation, and Tourism Management 1(1,0)** Multidisciplinary perspectives to examine concepts and methods related to professional development of parks, recreation, and tourism management graduate students. *Preq:* Admission to PRTM graduate program or consent of instructor.

**PRTM 991 Doctoral Dissertation Research 1-12**

## PHILOSOPHY

**PHIL 601 Studies in the History of Philosophy 3(3,0)** In-depth study of a selected philosopher, philosophical school, or movement. Topics vary. With departmental consent, may be repeated once for credit. Current topics and course descriptions are available in the department's course offering brochure. *Preq:* Consent of instructor.

**PHIL 602 Topics in Philosophy 3(3,0)** Thorough examination of a particular philosophical topic, issue, or problem. Topics vary. May be repeated once for credit with departmental consent. Current topics and course descriptions are available in the department's course offering brochure. *Preq:* Consent of instructor.

**PHIL 606 Continental Philosophy for Architects 3(3,0)** Examines contemporary Continental philosophy over the course of the 20<sup>th</sup> century, with the goal of offering the proper theoretical background to Architecture students who use such theory in their studies and design work.

**PHIL 625 Philosophy of Psychology 3(3,0)** Detailed examination of psychology as an autonomous science. Issues include explanation in psychology and cognitive neuroscience, psychology naturalized as a "special science" comparable to biology and geology, evolutionary psychology, philosophy and psychopathology, and moral issues in psychology. *Preq:* Nine hours of psychology or consent of instructor.

**PHIL (A A H) 633 Issues in Contemporary Art and Philosophy 3(3,0)** Examines the intersections between recent developments in art and those in philosophy and critical theory. Course content varies, for example, Postmodernism in Art and Philosophy, Themes of Resistance in Contemporary Culture.

**PHIL 685 Topics in Philosophy of Biology 3(3,0)** Detailed analysis of a selected topic in philosophy of biology/theoretical biology. Topics may include the levels of selection debate, sociobiology, genetic explanation and genetic causation, the species question, and the history and sociology of biology. *Preq:* Eight hours of biology or consent of instructor.

**PHIL 699 Independent Study 1-3(1-3,0)** Course of study designed by the student in consultation with a faculty member who agrees to provide guidance, discussion, and evaluation of the project. Student must confer with the faculty member prior to registration. May be repeated for a maximum of six credits. *Preq:* Consent of instructor.

**PHIL 845 Aesthetics 3(3,0)** Nature and value of aesthetic experiences and objects. Attention is directed to the roles of and relationships among objects, makers, and audiences; interpretation, criticism, and aesthetic response; the contexts and languages of art; the nature of aesthetic value; aesthetics in application; issues in public policy.

## PHYSICS

**PHYS 617 Introduction to Biophysics I 3(3,0)** Introduction to the application of physics to biological problems. Topics include elementary chemical and biological principles, physics of biological molecules, and fundamentals of radiation biophysics. *Preq:* MTHSC 206, PHYS 221, or consent of instructor.

**PHYS 620 Atmospheric Physics 3(3,0)** Study of physical processes governing atmospheric phenomena. Topics include thermodynamics of dry and moist air, solar and terrestrial radiative processes, convection and cloud physics, precipitation processes, hydrodynamic equations of motion and large-scale motion of the atmosphere, numerical weather prediction, atmospheric electricity. *Preq:* MTHSC 108, PHYS 208 or 221.

**PHYS 621 Mechanics I 3(3,0)** Statics, motions of particles and rigid bodies, vibratory motion, gravitation, properties of matter, flow of fluids. *Preq:* PHYS 221.

**PHYS 622 Mechanics II 3(3,0)** Dynamics of particles and rigid bodies, Lagrangian and Hamiltonian formulations, vibrations of strings, wave propagation. *Preq:* PHYS 321 or consent of instructor.

**PHYS 625 Experimental Physics I 3(1,4)** Introduction to experimental modern physics, measurement of fundamental constants, repetition of crucial experiments of modern physics (Stern-Gerlach, Zeeman effect, photoelectric effect, etc.) *Coreq:* PHYS 321 or consent of instructor.

**PHYS 626 Experimental Physics II 3(1,4)** Continuation of PHYS 325.

**PHYS 632 Optics 3(3,0)** Covers a selection of topics, depending on the interest of the student. Topics may include the formation of images by lenses and mirrors, design of optical instruments, electromagnetic wave propagation, interference, diffraction, optical activity, lasers, and holography. *Preq:* PHYS 221.

**PHYS 641 Electromagnetics I 3(3,0)** Study of the foundations of electromagnetic theory. Topics include electric fields, electric potential, dielectrics, electric circuits, solution of electrostatic boundary-value problems, magnetic fields, and magnetostatics. *Preq:* MTHSC 208 and PHYS 221, or consent of instructor.

**PHYS 642 Electromagnetics II 3(3,0)** Continuation of PHYS 441. Study of foundations of electromagnetic theory. Topics include magnetic properties of matter, microscopic theory of magnetization, electromagnetic induction, magnetic energy, AC circuits, Maxwell's equations, and propagation of electromagnetic waves. Other topics may include waves in bounded media, antennas, electrodynamics, special theory of relativity, and plasma physics. *Preq:* PHYS 441 or consent of instructor.

**PHYS 646 Solid State Physics II 3(3,0)** Continuation of PHYS 645, including selected topics in solid-state physics such as optical properties, superconductivity, noncrystalline solids, dielectrics, ferroelectrics, and nanomaterials. Plasmons, polarons, and excitons are discussed. Brief introduction into methods of solid-state synthesis and characterization tools is presented. *Preq:* PHYS 445 or consent of instructor.

**PHYS 652 Nuclear and Particle Physics 3(3,0)** Study of our present knowledge concerning subatomic matter. Experimental results are stressed. Topics include particle spectra, detection techniques, Regge pole analysis, quark models, proton structure, nuclear structure, scattering, and reactions.

**PHYS 655 Quantum Physics I 3(3,0)** Discussion of solution of the Schrodinger equation for free particles, the hydrogen atom, and the harmonic oscillator. *Preq:* PHYS 322 and 441 or consent of instructor.

**PHYS 656 Quantum Physics II 3(3,0)** Continuation of PHYS 455. Application of principles of quantum mechanics as developed in PHYS 455 to atomic, molecular, solid state, and nuclear systems. *Preq:* PHYS 455.

**PHYS 665 Thermodynamics and Statistical Mechanics 3(3,0)** Study of temperature development of the laws of thermodynamics and their application to thermodynamic systems. Introduction to low temperature physics is given. *Preq:* Six hours of physics beyond PHYS 222 or consent of instructor.

**PHYS 811 Methods of Theoretical Physics I 3(3,0)** Analytical methods and techniques used in theoretical physics: vector and tensor analysis as applied to physical problems, use of matrices and groups in classical and quantum mechanics, complex variables, and partial differential equations of physics.

**PHYS 812 Methods of Theoretical Physics II 3(3,0)** Continuation of PHYS 811. Use of integral transforms, integral equations, special functions, calculus of variations, and numerical approximations in solutions of physical problems.

**PHYS (M E) 815 Statistical Thermodynamics I 3(3,0)** Fundamental principles of kinetic theory and quantum statistical mechanics; Boltzmann statistics, Fermi-Dirac statistics, and Bose-Einstein statistics. *Preq:* A course in thermodynamics or consent of instructor

**PHYS 816 Statistical Thermodynamics II 3(3,0)** Generalized ensemble theory and fluctuations; applications to solids, liquids, gases, and blackbody radiation. *Preq:* PHYS (M E) 815.

**PHYS 821 Classical Mechanics I 3(3,0)** Dynamics of particles; variational principles and Lagrange's equations; two-body central force problems; dynamics of rigid bodies; matrix formulations freely used.

**PHYS 822 Classical Mechanics II 3(3,0)** Special relativity in classical mechanics; Hamilton's equations; canonical transformations; Hamilton-Jacobi theory; small oscillations.

**PHYS 841 Electrodynamics I 3(3,0)** Field theory of electromagnetism; Maxwell's equations and their application to study of electromagnetic wave production and propagation; wave optics and theories of interference and diffraction.

**PHYS 842 Electrodynamics II 3(3,0)** Production and propagation of electromagnetic waves beginning with use of Maxwell's equations; wave guides; diffraction phenomenon; boundary effects; theory of electrons and microscopic phenomena.

**PHYS 845 Solid State Physics I 3(3,0)** Physical properties of crystalline solids; crystalline state determination by diffraction methods; theories of specific heat; properties of metallic lattices and alloys; lattice energy and ferroelectrics.

**PHYS 846 Solid State Physics II 3(3,0)** Continuation of PHYS 845. Electronic properties of solids, band theory of solids, physics of semiconductors, theories of magnetism, and magnetic resonance phenomena.

**PHYS 852 Radiation Physics 3(3,0)** Interactions and basic mechanisms involved in the natural radiation environments of space, which include a variety of energetic, charged particles with sufficient energy to penetrate heavily shielded spacecraft and pose potential hazards to astronauts and electronic systems. *Preq:* Undergraduate degree in Physics or Electrical Engineering or consent of instructor.

**PHYS 875 Selected Topics 1-3(1-3,0)** Students and interested faculty study areas of physics currently being extensively investigated. May be repeated for credit, but only if different topics are covered.

**PHYS 890 Directed Activities in Applied Physics 1-6** Training and work on practical problems are supervised by department faculty or by appropriate adjunct professor. Written description of student's activities must be submitted to course supervisor at completion of activity. Maximum credit limits are six credit hours in a semester and three credit hours in a single summer session. To be taken Pass/Fail only.

**PHYS 891 Master's Thesis Research 1-12**

**PHYS 951 Quantum Mechanics I 3(3,0)** Review of wave mechanics, operator algebra and theory of representation, approximate methods for stationary problems, theory of scattering applied to atomic and nuclear problems.

**PHYS 952 Quantum Mechanics II 3(3,0)** Continuation of PHYS 951. Time-dependent perturbations, radiation, absorption and emission, relativistic quantum mechanics, introduction to quantum electrodynamics.